Bulletin No. 19 *Mineral Technology Series No. 10*

University of Arizona Bulletin

CHARLES F. WILLIS, *Director*

Gypsum

By Frank L. Culin, Jr.

PUBLISHED BY THE

University of Arizona
Bureau of Mines

TUCSON, ARIZONA

1915-16

BIBLIOGRAPHY

Adams, G. I. and others. Gypsum deposits of the United States. U. S. G. S. Bull. 223. 123 pp. 1904.

Boutwell, J. M. Rock gypsum at Nephi, Utah. U. S. G. S. Bull. 225. pp. 483-487. 1904.

Burchard, E. F. Gypsum deposits in Eagle Co., Colo. U. S. G. S. Bull. 470. pp. 354-366, 1911.

..... Gypsum. U. S. G. S. Mineral Resources of U. S. for 1909, part II, pp. 639-645, 1911.

Eckel, E. C. Gypsum and gypsum products. U. S. G. S. Mineral Resources of the U. S. for 1905, pp. 1105-1115, 1906.

Harder, E. C. The gypsum deposits of the Palen Mts., Riverside Co., Cal. U. S. G. S. Bull. 430, pp. 407-416, 1910.

Hess, F. L. A reconnaissance of the gypsum deposits of California. U. S. G. S. Bull. 413, 37 pp. 1910.

..... Gypsum deposits near Cane Springs, Kern Co., Calif. U. S. G. S. Bull. 430, pp. 417-418, 1910.

Kay, G. F. A new gypsum deposit in Iowa. U. S. G. S. Bull 580 E. pp. 59-64. 1914.

Lipton, C. T. Gypsum along the west flank of the San Rafael Swell, Utah. U. S. G. S. Bull. 530, pp. 221-231, 1913.

Orton, Edward. Gypsum or land plaster in Ohio. U. S. G. S. Mineral Resources of the U. S. for 1887, pp. 596-601, 1888.

Parker, E. W. Gypsum. U. S. G. S. 21st Ann. Rept. part 6 (cont.) pp. 523-530, 1901.

Shaler, M. K. Gypsum in Northwestern New Mexico. U. S. G. S. Bull, 315, pp. 260-265, 1907.

Stone, R. W. Gypsum industry in 1912 and 1913. U. S. G. S. Mineral Resources of U. S. for 1912 and 1913; 1913 and 1914.

..... Gypsum, the mineral industry during 1912, pp. 440-450, 1913.

Blake, W. P. Gypsum in Arizona. American Geologist, XVIII, p. 394, 1896.

GYPSUM

By Frank L. Culin, Jr.

The gypsum industry is a growing one, and will apparently continue to grow for some time. Producers report better trade conditions for 1913 than for 1912. In ten years the production has jumped from 1,000,000 tons of crude gypsum in 1903 to more than 2,500,000 tons in 1913.

Gypsum was produced in eighteen states and in Alaska. Eighty-two quarries or mines were worked, while the total number of mills reported in 1913 was 67. New York was the largest producer of raw gypsum; Iowa ranked second and Michigan third.

Gypsum finds its chief use in the manufacture of various plasters, such as plaster of Paris, molding and casting plaster, stucco, so-called "cement" plaster or hard wall plaster, flooring plaster, hard finish plaster, etc. Refined grades of gypsum plaster are used in dental work, in the plate glass industry, and for making molds of various kinds, as for pottery, stereotypes, rubber stamps, etc. It is also used as a fertilizer, in paints, for interior decoration (alabaster) and for many other purposes (see Uses).

Gypsum imported into the United States comes almost entirely from Nova Scotia and New Brunswick, entering through the ports of the North Atlantic states and New England.

OCCURENCE.

Gypsum occurs in three varieties: (1) Crystallized, or selenite; (2) fibrous, either coarse or fine, called satin spar; (3) massive, alabaster and earthy or rock gypsum.

The mineral anhydrite is also used in the gypsum industry. This mineral is anhydrous gypsum—that is, gypsum without the molecule of water.

GYPSUM

Composition: Gypsum is a hydrous calcium sulphate, ($CaSO_4$+ H_2O) sulphur trioxide (SO_3) 46.6% lime (CaO) 32.5%, and water (H_2O) 20.9%.

Form: Gypsum occurs in three forms:

1. Crystallized, or selenite; colorless, transparent, in distinct crystals or broad folia, somewhat flexible, and having a fibrous fracture.

2. Fibrous, coarse or fine. Called satin-spar; when fine, it is fibrous, with pearly opalescence.

3. Massive; alabaster, a fine grained variety, white or delicately shaded; earthy or rock gypsum, a dull colored rock, often impure with clay, calcium carbonate or silica.

Gypsum crystallizes in the mono-clinic system, the crystals usually being simple, and commonly flattened.

Color: Usually white, sometimes gray, reddish yellow, blue; impure varieties often black, brown, red, or reddish brown. Transparent to opaque.

Lustre: In crystalline and fibrous forms, pearly and shining to subvitreous. Massive varieties often glistening, sometimes dull earthy.

Hardness: Soft (1.5-2).

Weight: Light. Sp. Gr. 2.314—2.328.

Streak: White.

Occurrence: Forms extensive beds in connection with various stratified rocks, especially limestones, and clay beds. It occurs occasionally in crystalline rocks. Is also a product of volcanoes, occurring where sulphur gases are escaping. It is produced also by the decomposition of pyrite when lime is present. When found in extensive beds, it has been precipitated from sea-waters.

Blowpipe Tests: In the closed tube gives off water and becomes opaque. Fuses at 2.5-3 (readily fusible), coloring the flame reddish yellow. Ignited at a temperature not exceeding 26 degrees C., it again combines with water when moistened, and becomes firmly solid. Soluble in HC1 (hydrochloric acid), and also in 400 to 500 parts of water.

ANHYDRITE

Composition: Anhydrous calcium sulphate, $CaSO_4$. Sulphur trioxide (SO_3) 58.8% lime (CaO) 41.2%.

Form: Crystallizes in the orthorhombic system. Crystals are not common. Usually massive, cleavable, fibrous, lamellar, and granular.

Color: White, also grayish, bluish, and reddish.

Streak: Grayish white.

Hardness: Slightly harder than gypsum. (3-3.5) Brittle.

Weight: Light. Sp. Gr. 2.899—2.985.

Occurrence: In limestone strata, often with gypsum; very common in rock salt beds.

Blowpipe Tests: Fuses rather easily (3), coloring the flame reddish yellow, and yielding an enamel like bead which reacts alkaline. On charcoal in reducing flame is reduced to a sulphide; with

soda does not fuse to a clear globule, and is not absorbed by the coal like barite. It is decomposed, yielding a mass that blackens silver. Soluble in hydrochloric acid.

USES OF GYPSUM

The greater part of the gypsum produced in the United States and in foreign countries as well, is manufactured by grinding and by partial or complete calcination into the various plasters, such as plaster of Paris, molding and casting plaster, stucco, so-called "cement" plaster or hardwall plaster, flooring plaster, hard finish plaster, etc. Refined grades of gypsum are used in dental work, in the plate glass industry, for making pottery molds, stereotype molds, molds for rubber stamps, and in various patent cements. The use of raw gypsum as a retarder in Portland cement is steadily increasing. Large quantities are ground without burning and used as land plaster or fertilizer. To a lesser degree gypsum is used in the manufacture of paints, wall tints, crayon, paper, imitation meerschaum and ivory, and as an adulterant. The variety alabaster is much used for interior decoration. The variety selenite (the crystallized form) is in great demand for optical purposes, especially in the manufacture of scientific optical instruments. For this purpose the crystals must be very pure and free from flaws of any kind.

A high grade of rock gypsum, in the pure or "neat" condition, is required for plaster of Paris and for dental molding and casting plasters. No foreign substance or retarder is used. These plasters are quick setting, and are white in color.

Most of the so-called cement plaster is made from gypsite, an earthy, unconsolidated or sandy form of gypsum, with the addition of a suitable retarder. In many cases the foreign material contained in the gypsite is sufficient to take the place of any other retarder. If gypsite is ont to be had, these plasters are made from rock gypsum, by the addition of various minerals or organic retarders.

A large part of the structural plaster now produced is gotten up in specially prepared forms for the convenience of the builder, as plaster board, solid and hollow blocks, and tiles. Plaster board is pressed from plaster interlaminated with thin sheets of cardboard felt or wood. It is furnished in various sizes and thicknesses. It is designed to be nailed directly to the studding, and to receive a coat of wall plaster on its outer surface. Blocks and tiles are molded from fibred plaster, and are used for interior partitions and for roofing. This type has proved to be of value as a fire retarder. Gypsum tiles are lighter than clay tiles, are straight and true, can be cut with

a hand saw and because of their lightness and size, can be laid very rapidly. Gypsum blocks have been used for exterior construction in some places, especially where the climate is arid, and has proven satisfactory. Gypsum has been extensively used for the exterior finish of temporary structures, such as exposition buildings.

By far the most important single use of gypsum in this country is in the manufacture of plaster, especially wall plasters. Hard wall plaster consists of plaster of Paris, a fibre, as hair or wood fibre, and a retarder. It is of two general grades, one having a brown or gray coat, and the other a white or tinted finish coat. It is a little more expensive than lime, and not so good as lime for deadening sound, but is more convenient to handle than lump lime, and, due to its rapid setting, permits a job to be completed in less time.

Under the name of "Keene's" cement, a number of hard-finish anhydrous plasters are made from gypsum. This is made by adding alum or borax to de-hydrated, or calcined gypsum. This makes a very white and very hard plaster. It is used both as a wall and flooring plaster.

Gypsum is also used in the manufacture of calcimines, water paints and tints, and as an ingredient in dry colors. When used in excess in mixed paints, it is regarded as an adulterant, but it may be used to a certain extent with oil paints, because it is chemically inactive, provided it is in unburned or dead-burned form.

Some claim that the strength of gypsum plasters decrease with time. This may be true, or may not; at any rate the decrease, if any, is so very slight that it is hardly appreciable.

METHODS OF PREPARATION

In preparing the gypsum for market the stone is first broken in a crusher to about half or three-quarter inch size. It is then ground to a proper degree of fineness. If it is to be used for stucco it is calcined after being ground. In preparing some of the patent plasters, various adulterants and retarders are used. It is usually packed in bags or barrels.

THE GYPSUM INDUSTRY

In the United States there are 18 states producing gypsum, as well as Alaska. In 1913 there was a production of 2,599,508 tons of raw gypsum, as against 2,500,757 tons in 1912, an increase of 98,751 tons. Gypsum sold for use in Portland cement and paint, and as land plaster amounted to 463,136 tons, valued at $697,066. The total value of gypsum and gypsum products produced in 1913

was $6,774,822, as compared with $6,563,980 in 1912, an increase of $210,914. In 1914 the tonnage of gypsum produced was less than in 1913, but due to the advance in price of calcined gypsum the value of the product increased. 2,476,465 tons were mined in 1914, a decrease of 123,043 tons from 1913. The total value, however, was $6,895,989, an increase of $121,167 over 1913. The states producing gypsum and their rank remained unchanged during 1914.

New work was the largest producer, followed by Iowa. It is also produced in the following states: Ohio, Texas, Kansas, Nevada, Oklahoma, Wyoming, Arizona, Colorado, Montana, New Mexico, South Dakota, Utah, Virginia, Oregon, and Alaska. Sales of gypsum products are credited to Illinois, Minnesota, Washington, and Wisconsin, although these states are not producers.

Practically all of the gypsum imported into the United States comes from Nova Scotia, and New Brunswick. There was an increase in both quantity and value of imports in 1913—the total importation of unground gypsum in 1913 being 447,383 tons, valued at $473,594. The quantity of ground or calcined gypsum imported is very small.

In foreign countries, France is the largest producer of gypsum, and ranks next to the United States in the world's production; the value of gypsum produced in France in 1911 being well over $3,000,000. Gypsum is also produced in Algeria, Australia, Canada, Cyprus, Bavaria, Greece, India, and the United Kingdom.

ARIZONA DEPOSITS

Gypsum occurs at several localities in Arizona, the following being noteworthy: Navajo County, Fort Apache Reservation, Snowflake, Winslow, and Woodruff; Cochise and Pinal Counties, along the San Pedro River, and at Douglas; Pima County, in the foothills of the Santa Catalina Mountains north of Tucson, and in the Santa Rita Mountains southeast of Tucson. The gypsum deposits in the Santa Rita Mountains are of considerable thickness and extent. The occurrence on Fort Apache Reservation consists of large selenite crystals. It has been quarried at Douglas since 1908 and at Winslow since 1909.

Another deposit has lately been discovered near Winkelman, Pinal County. U. S. Geological Survey men say that this deposit is the largest and most extensive deposit of high grade gypsum in the United States. This deposit will probably be worked in the near future.

GEOLOGICAL CONDITIONS AND RELATIONS

Gypsum occurs most frequently in sedimentary rocks, interbedded with shales, sandstones and limestones, and often closely associated with rock salt. It is also found as surface deposits mixed with clay (gypsite) or in the form of sand. It is often found in limited quantities in volcanic regions, especially in lavas.

Practically all bedded deposits of gypsum have been formed by the evaporation of salt waters, either in inland seas, or in arms of the ocean. Gypsum may also be formed by the decomposition of sulphides, as pyrite, and the action of the sulphuric acid thus liberated on lime rocks. In volcanic regions, gypsum is formed by the action of sulphuric vapors on the lime of volcanic rocks.

PRICES AND ECONOMIC CONSIDERATIONS

The average proce of land plaster per ton at the mill was $1.75 in 1913, a lower price than the same material brought in the three years previous. The average price of gypsum sold for the manufacture of paint, for Portland cement, for bedding plate glass, and for other purposes, was $1.47 per ton in 1913, as compared with $1.33 in 1912. The average price of calcined gypsum products, including wall plaster, plaster of Paris, Keene's cement, and dental plaster, was $3.43 per ton in 1913, the same as in 1912. The average price of unground, imported gypsum was $1.058 per ton in 1913.

The commercial value of gypsum depends largely upon its accessibility to the market, and its purity. These two features, of course, play a very important part in the development of any mineral industry and must be carefully considered.

FUTURE OF THE INDUSTRY

An investigation of some of the figures on production and price of gypsum in the past ten years show that the industry has had a very substantial growth. With the increasing use of gypsum in wall plasters, Keene's cement, as a fertilizer, and in various other forms, a future growth seems well assured.

In Arizona, however, the industry cannot be expected to assume much importance until transportation facilities are improved, nor until the population has increased to such an extent that a strong local demand for gypsum products will be created.